

Unlike current wave-guides made from just one type of material that has a speed of sound of around 5000 meters per second and a Poisson's ratio of about 0.3, (e.g., aluminum alloys, titanium, titanium alloys and steel), use of a high speed of sound/low Poisson's ratio material for the novel mode stabilizer 1204a of the present invention prevents a "neck down" effect from occurring. Specifically, if a conventional material were used for the mode stabilizer 1204a, the face of the mode stabilizer 1204a to which the sub-motors 1341 are attached would bow and flex from a concave to a convex shape, i.e., the master wave-guide 1204 would become narrower in the center during operation. This would cause the sub-motors [to] 1341 to vibrate sideways at very high acceleration levels, leading to probable early failure of the transducer 1221. By using a material with an adequately low Poisson's ratio and high speed of sound for the mode stabilizer 1204a, the transverse direction is substantially insensitive to motion occurring in the axial direction. As a result, each sub-motor 1341 moves primarily in one direction, and does not wobble from side to side.

Please amend the last paragraph beginning on page 48, line 27 as follows:

As with the single motor embodiment, each drive rod 1342 is changeable between a first shape in the absence of a magnetic [filed] field or a low magnetic field and a second shape when in the presence of a magnetic field or in a higher magnetic field. In one embodiment, the magnetic domains present in each drive rod 1342, such as with the use of giant magnetostrictive materials as the drive rod material, align around the longitudinal axis 1322 when a magnetic field parallel to the longitudinal axis 1322 is applied to the drive rods 1342. This alignment of the magnetic domains causes the drive rods 1342 to elongate. A sinusoidal input signal is provided to the drive coil 1351 for producing a changing electromagnetic field which has the same frequency as the input signal, and extends through each drive rod 1342. Specifically, the input passes through the foil in the drive coil 1351 and causes an alternating electromagnetic field to be generated by the drive coil 1351 through each drive rod 1342 as discussed herein.

IN THE CLAIMS

Please substitute the claim set in the appendix entitled Clean Version of Pending Claims for the previously pending claim set. The substitute claim set is intended to reflect amendment of

previously pending claims 19, 25 and 29. The specific amendments to individual claims are detailed in the following marked up set of claims.

19. (Twice Amended) A high power ultrasonic transducer comprising a housing having a predetermined geometry, means carried by the housing for providing power in excess of three kilowatts, including a transducer having a cylindrical actuation element made from a giant magnetostrictive material and a coil made from electrically conductive wire concentrically disposed about the cylindrical element for producing an electromagnetic field that extends through at least a portion of the cylindrical element, the cylindrical element changeable between a first shape when in the absence of the magnetic field and a second shape when in the presence of the magnetic field, means for supplying an electrical signal to the coil and an acoustic element connected to the transducer for vibrating at an ultrasonic frequency in response to the transducer for performing work, the transducer capable of performing work on a continuous basis.

25. (Amended) The ultrasonic transducer of Claim 24 wherein the first and second flux return means are adjacent to the first and second end portions of the tubular magnetic means.

29. (Twice Amended) A high power magnetostrictive ultrasonic actuator comprising an active element made from a giant magnetostrictive material having first and second ends, the giant magnetostrictive element changeable from a first shape to a second shape in the presence of a magnetic field, means for producing a magnetic field which extends through at least a portion of the active element and first and second flux return elements adjacent to the first and second ends of the giant magnetostrictive element for capturing magnetic flux produced by said means and directing the magnetic flux through the giant magnetostrictive element, wherein the high power magnetostrictive ultrasonic actuator contains a refrigeration system.

REMARKS

Applicant has carefully reviewed and considered the Office Action mailed on March 21, 2002, and the references cited therewith.

Claims 19, 25 and 29 are amended, as a result, claims 1-8, 10-14, 16-20, 22, 24, 25 and 27-74 are now pending in this application.

Applicant's Representative, Barbara Clark, conducted a brief telephonic interview with the Examiner on May 24, 2002 to clarify discrepancies between the claims indicated as allowed on the cover sheet of the Office Action mailed on March 21, 2002 and the claims that were objected to on page 4 of the Office Action. The Examiner agreed that, contrary to the language on page 4, claims 24, 25 and 27-28 are allowed. Ms. Clark thanks the Examiner for the courtesies extended to her during the interview. The Examiner also clarified, on June 12, 2002, that claims 29-31 are not allowed, but stand rejected, as noted on page 3 of the Office Action. (These claims were noted as both allowed and rejected on the cover sheet of the Office Action).

The specification was amended to correct errors. Typographical errors were corrected in the paragraphs beginning on page 30, line 30 and page 48, line 27. The paragraph beginning on page 6, line 11, was corrected to clarify that each motor assembly of Applicant's multiple motor embodiment does *not* have its own means of producing an electromagnetic field, thus providing consistency with all other descriptions of this embodiment. (Such motor assemblies are also referred to as "sub-motors" in the specification). No new matter has been added as a result.

The claims have been amended to define Applicant's invention with greater particularity. The amendments to the claims have support throughout the specification. No new matter has been added as a result. The amendments are made to clarify the claims and are not intended to limit the scope of equivalents to which any claim element may be entitled. Applicant respectfully requests reconsideration of the above-identified application in view of the amendments above and the remarks that follow.

Claim 19 was amended to recite that the transducer can operate on a continuous basis. Support for this can be found in allowed claim 32.

Allowed Claim 25 was amended to correct the unintentional omission of the word "to."

Claim 29 was amended to recite a refrigeration system connected to the transducer. Support for this amendment can be found in allowed claim 32.

Information Disclosure Statement

Applicant filed an Information Disclosure Statement on September 29, 2000. Applicant received a copy of the 1449 Form indicating that all documents cited therewith were considered, with the exception of German Patent No. 4,041,063. Copies of the English abstract, German Patent No. 4,041,063, the previously filed Form 1449 and Information Disclosure Statement are attached for the Examiner's convenience.

Applicant respectfully requests that a copy of the 1449 Form listing this document be returned with the next official communication once marked as being considered and initialed by the Examiner.

§103 Rejection of the Claims

Rejection of claims 1, 2 and 19

Claims 1, 2 and 19 were rejected under 35 USC § 103(a) as being unpatentable over Paul et al. (U.S. 5,824,214) in view of Patzner (U.S. 5,727,628).

The Examiner states that Paul discloses a high power ultrasonic transducer, but does not disclose how much power is provided. The Examiner further states that Patzner teaches connecting ultrasonic transducers together in order to perform more work in a given amount of time, and since the references are both from the same field of endeavor, it would have been obvious to add more transducers in the device of Paul in order to hydrotreat heavy crude oil faster. The Examiner further notes that Patzner states that adding more transducer elements would require more power for the transducer.

Applicant respectfully submits that the Examiner has not established *prima facie* obviousness of the present claims. To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the cited references themselves or in the knowledge generally available to an art worker, to modify the reference or to combine reference teachings so as to arrive at the claimed invention. Second, the

art must provide a reasonable expectation of success. Finally, the prior art reference must teach or suggest all the claim limitations. In re Ochiai, 37 USPQ2d 1127 (Fed. Cir. 1997) (When evaluating the scope of a claim, every limitation in the claim must be considered).

Paul does not teach or suggest the claimed invention. Paul repeatedly states that his device operates in the sonic frequency range of 400 Hz to 10 kHz. (See, for example, the Abstract; col. 3, line 14; col. 4, line 3; col. 5, line 5; col. 8, lines 17 and 32 and every independent claim, e.g., 1, 6, 10, 14, 17, 20, 24, 28, 32 and 36). Although there is mention in col. 4, line 18 of frequencies in the ultrasonic range, at best, this is a generalized reference to the capabilities of Terfenol-containing T-MotorsTM. Even with such an interpretation, this does not imply that the device of Paul is capable of operating in the ultrasonic range, as such devices are fundamentally different than sonic devices, and such differences must be recognized. What is puzzling with the language the Examiner has relied on to conclude that Paul operates in the ultrasonic range is that Paul himself refers to the stated range of "10 to 50 kHz to 400 Hz" as a "sonic" range, even though frequencies in excess of about 18 kHz are considered by those skilled in the art to be "ultrasonic." Furthermore, Paul lists the highest frequencies first (i.e., 10 -50 kHz) with the lowest frequency of his range noted last, i.e., 400 Hz. This is in contrast to the approximately sixteen other mentions of his sonic frequency range, which were stated in the conventional manner from a lower to a higher frequency, i.e., 400 Hz to 10 kHz. It is quite possible that there is a typographical error contained within the range presented in col. 4, line 18, and that Paul did not even intend to note the general ultrasonic capabilities of a T-MotorTM. This is evidenced by the other uses of the word "sonic" within the same paragraph. For example, Paul states that the heavy crude oil is subjected to sonic vibrations (col. 4, line 2) and further refers to the T-MotorTM being used to transmit sonic energy into zone 32 (col. 4, lines 24-25).

Additionally, although the Examiner characterizes Paul as a "high power" device, there is simply no evidence that this device is a high power device. High power devices are fundamentally different than low power devices, as is known in the art, requiring a number of design considerations not addressed in Paul. As the Examiner admits, Paul does not discuss the amount of power provided.

In contrast, claims 1 and 19 each recite a transducer with means for providing power in

excess of three kilowatts and an acoustic element connected to the transducer for channeling ultrasonic energy to perform work (claim 1) or for vibrating at an ultrasonic frequency in response to the transducer for performing work (claim 19).

Patzner does not overcome the deficiencies of the primary reference. Patzner discusses ultrasonic transducers, each capable of functioning as a stand-alone transducer, i.e., Patzner discusses *multiple single transducers, each with their own electromagnetic field*.

In contrast, claim 1 recites one or more active elements in a high power ultrasonic transducer. The multiple elements in Applicant's invention are not capable of functioning as stand-alone transducers. Rather, Applicant's device has, in one embodiment, *multiple elements in a single transducer together with means for producing an (i.e., one) electromagnetic field*, as recited in claims 1-2.

The devices of the references are further not designed for continuous work. Claim 19, as amended, recites a high power ultrasonic transducer capable of performing work on a continuous basis.

Even if Paul is considered to include ultrasonic frequencies (which Applicant respectfully submits it does not), there is no suggestion in Paul *as to the desirability* of connecting multiple transducers together as in Patzner or of providing a high power transducer. Applicant requests the Examiner to either provide evidence of such motivation or withdraw this rejection. See also In Re Sang Su Lee, No. 00-1158 (Serial No. 07/631,240), (Fed. Cir.), decided January 18, 2002 (attached hereto).

Furthermore, there is no indication in either reference of the problem being solved by Applicant's invention, i.e., providing a high power ultrasonic transducer (in excess of 3 kW), the transducer having one or more active elements and means (claim 1) or a coil (claim 19) for producing an electromagnetic field. It is simply not clear that the prior art can be modified in the manner suggested by the Examiner, although the mere fact that the prior art may be modified in this manner does not make the modification obvious unless the prior art suggested the desirability of the modification. Uniroyal Inc. v. Rudkin-Wiley Corp., 837 F.2d 1044, 5 USPQ2d 1434 (Fed. Cir. 1988).

Applicant further questions whether the two references are in the same field of endeavor.

Paul is not concerned with the unique issues associated with a high power ultrasonic device and the frequencies of the multiple single transducers in Patzner are inherently outside the range of the sonic vibrations in Paul. Clearly, the device in the primary reference and the device in the secondary reference are fundamentally different from each other and such critical differences must be recognized. In re Bond, 910 F.2d 831, 834, 15 USPQ2d 1566, 1568 (Fed. Cir. 1990), reh'g denied, 1990 U.S. App. LEXIS 19971 (Fed. Cir. 1990).

In any case, the suggested combination does not teach each and every element of the claims, as amended. Furthermore, claim 2 is dependent on claim 1 which has been amended as noted above. The additional limitations provided in dependent claim 2 cannot by itself be rendered obvious over the cited references if the independent claim from which it depends is determined to be nonobvious.

The references neither independently, or combined, contain each and every element of Applicant's claimed invention. Applicant respectfully submits that independent claims 1 and 19, as well as claim 2, which depends from claim 1, are patentably distinct from Paul et al in view of Patzner, either alone or in combination. Claims 1, 2 and 19, as amended, each viewed as a whole, are not suggested by the cited references and not obvious under 35 U.S.C. 103.

Reconsideration and withdrawal of this rejection is respectfully requested.

Rejection of claims 3 and 10

Claims 3 and 10 were rejected under 35 USC § 103(a) as being unpatentable over Paul et al. in view of Patzner, and further in view of Owen (U.S. 5,109,698).

The Examiner states that Paul as modified by Patzner discloses the transducer, but does not disclose magnetic means for biasing the active element and that magnetic biasing is well known in the art. The Examiner further states that Owen teaches magnetic biasing and that since Owen and Paul as modified by Patzner are both from the same field of endeavor, it would have been obvious for one of ordinary skill to have utilized magnetic biasing in the device of Paul as modified by Patzner in order to make the magnetostrictive device operate in a predicable and linear fashion.

Applicant again respectfully submits that the Examiner has not established the *prima*

facie obviousness of the present claims.

Owen teaches various configurations of cylindrically shaped transducers as borehole seismic wave sources.

Again, there is simply no suggestion *as to the desirability*, either in the cited references themselves or in the knowledge generally available to an art worker, of modifying the references as described or to combine the reference teachings as suggested for all of the reasons stated above. See In Re Sang Su Lee, *supra*. Clearly, the devices in each of the references cited are fundamentally different from each other and such critical differences must be recognized.

Applicant does not claim to have invented the first device using magnetic biasing. Applicant is the first however, to provide the device recited in claim 1, as amended.

Furthermore, claims 3 and 10 are dependent on claim 1. The additional limitations provided in dependent claims 3 and 10 cannot by themselves be rendered obvious over the cited references if the independent claim from which it depends is determined to be nonobvious.

The references neither independently, or combined, contain each and every element of Applicant's claimed invention. Applicant respectfully submits that independent claim 1, and claims 3 and 10 which depend from claim 1, are patentably distinct from the references, either alone or in combination. Claims 3 and 10, each viewed as a whole, are not suggested by the cited references and not obvious under 35 U.S.C. 103. Reconsideration and withdrawal of this rejection is respectfully requested.

Claims 7 and 29-31

Claims 7 and 29-31 were also rejected under 35 USC § 103(a) as being unpatentable over Paul et al. as modified by Patzner and Owen, and further in view of Porzio et al. (U.S. 4,845,450).

The Examiner states that Paul, as modified by Patzner and Owen discloses the transducer, but does not disclose flux return elements. The Examiner further states that Porzio discloses flux return elements and that it would have been obvious to use flux return elements in the device of Paul as modified by Patzner and Owen.

Applicant again respectfully submits that the Examiner has not established the *prima facie* obviousness of the present claims.

Porzio teaches a self-biased modular magnetostrictive driver and transducer.

Again, there is simply no suggestion *as to the desirability*, either in the cited references themselves or in the knowledge generally available to an art worker, of modifying the references as described or to combine the reference teachings as suggested for all of the reasons stated above. See In Re Sang Su Lee, *supra*. Clearly, the devices in each of the references cited are fundamentally different from each other and such critical differences must be recognized.

Applicant does not claim to have invented the first device using flux return elements. Applicant is the first however, to provide a high power magnetostrictive ultrasonic actuator comprising an active element made from a giant magnetostrictive material having first and second ends, the giant magnetostrictive element changeable from a first shape to a second shape in the presence of a magnetic field, means for producing a magnetic field which extends through at least a portion of the active element and first and second flux return elements adjacent to the first and second ends of the giant magnetostrictive element for capturing magnetic flux produced by said means and directing the magnetic flux through the giant magnetostrictive element, wherein the high power magnetostrictive ultrasonic actuator contains a refrigeration system, as recited in claim 29, as amended.

Furthermore, claim 7 is dependent on claim 1. Claims 30-31 are dependent on claim 29, which has been amended as noted above. The additional limitations provided in dependent claims 7, 30 and 31 cannot by themselves be rendered obvious over the cited references if the independent claim from which it depends is determined to be nonobvious.

The references neither independently, or combined, contain each and every element of Applicant's claimed invention. Applicant respectfully submits that claim 7, which indirectly depends from claim 1, independent claim 29 and claims 30-31, which depend from claim 29, are patentably distinct from the references, either alone or in combination. Claims 7 and 29-31, as amended, each viewed as a whole, are not suggested by the cited references and not obvious under 35 U.S.C. 103. Reconsideration and withdrawal of this rejection is respectfully requested.

Claim 12

Claim 12 was also rejected under 35 USC § 103(a) as being unpatentable over Paul et al.

as modified by Patzner, and further in view of Wuchinich (U.S. 4,425,115)

The Examiner states that Wuchinich teaches making an ultrasonically vibrating piece driven by a magnetostrictive actuator from an acoustic metal. The Examiner recognizes that Wuchinich is designed for surgically removing body tissue, but states that the problem of damping vibrations of an ultrasonic device applies to magnetostrictive actuators for hydrotreating crude oil as well. The Examiner further states that since Wuchinich and Paul, as modified by Patzner are both magnetostrictive ultrasonic vibrators, it would have been obvious to use an acoustic element made from an acoustic metal in the device of Paul.

Applicant again respectfully submits that the Examiner has not established the *prima facie* obviousness of the present claims.

Wuchinich teaches an ultrasonic resonant vibrator having a connecting portion connecting an ultrasonic vibration transducer to a tool which ultrasonically vibrates at one end for fragmenting contacted tissue.

Again, there is simply no suggestion *as to the desirability*, either in the cited references themselves or in the knowledge generally available to an art worker, of modifying the references as described or to combine the reference teachings as suggested for all of the reasons stated above. See In Re Sang Su Lee, *supra*. Clearly, the devices in each of the references cited are fundamentally different from each other and such critical differences must be recognized.

Applicant does not claim to have invented the first device using acoustic metal. Applicant is the first however, to provide the device recited in claim 1.

Furthermore, claim 12 is dependent on claim 1. The additional limitations provided in dependent claim 12 cannot by themselves be rendered obvious over the cited references if the independent claim from which it depends is determined to be nonobvious.

The references neither independently, or combined, contain each and every element of Applicant's claimed invention. Applicant respectfully submits that independent claim 12 is patentably distinct from the references, either alone or in combination. Claim 12, viewed as a whole, are not suggested by the cited references and not obvious under 35 U.S.C. 103. Reconsideration and withdrawal of this rejection is respectfully requested.